U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION 2

PUERTO RICO STORM WATER PUMP STATIONS SAMPLING RESULTS

January 2007

Dates of Sampling: August 21 - 24, 2006

Inspection Participants: Bill Hahn, SAIC
Brandon Peebles, SAIC
Daniel Quinones, SAIC
Carols Villafane, EPA Caribbean Field Office

Puerto Rico Storm Water Pump Station Sampling Results

1. Introduction

On August 21 through August 24, 2006, SAIC provided support to the U.S. Environmental Protection Agency (EPA) Region 2 by conducting sampling at four storm water pump stations operated by the Puerto Rico Department of Natural Resources. SAIC also sampled a domestic sewage pump station to provide reference concentrations for the parameters sampled. A storm water discharge pipe that discharges to San Juan Bay was also sampled as part of the effort. The purpose of the sampling effort was to characterize the discharge flows at four storm water pump stations and one relief sewer.

Chemical parameters and BOD were sampled using equal volume grab samples collected and composited during the day shift operations. For bacterial analysis each grab sample collected was analyzed separately.

Bacterial samples collected on August 21, 22, and 23 were analyzed by Environmental Quality (EQ) Laboratories, Inc., located in Santurce, PR. The Puerto Rico Environmental Quality Laboratory analyzed the bacterial samples collected on August 24. All BOD samples were analyzed by EQ Laboratories.

Photographs obtained during the inspection are provided in Attachment 1.

2. Summary

Each of the sampling locations showed some contribution of domestic wastewater commingled with the storm water being discharged. SAIC estimated the level of contamination ranged from 10 to 44 percent of the discharge volume at the Baldorioty de Casto, and De Deigo Storm Water Pump Stations. Results at the La Malaria Pump Station indicated that the contribution of domestic sewage could range from 10 to 34 per cent, the results were somewhat ambiguous and SAIC cannot conclude with certainty that there is significant sanitary sewage contamination of the water at that location. At the Stop 18 Storm Water Pump Station and the Miramar relief sewer, the sanitary wastewater contribution was estimated to be 61 and 77 percent respectively, however these estimates were based on a single set of chemical parameters at each location. All of these discharges go untreated to surface waters.

3. Analytical Parameters Sampled

Storm water collection systems are intended to convey urban storm water runoff to surface waters in order to prevent localized flooding. While intended to only carry surface runoff, ground water may also enter the underground pipes through defective joints, cracks, holes and other defects. They may also collect domestic, commercial, and industrial wastewater through illegal connections.

The goal of the sampling program was to identify the extent that domestic sewage is entering the storm water discharges either through illegal connections or as the result of failed septic systems. The program also sought to identify, where possible, contributions from commercial or industrial sources. An ideal "tracer" compound to identify domestic wastewater contamination would be present only in domestic wastewater sources, be conservative (i.e., maintain a constant concentration over time), and be relatively easy to measure. The presence of this tracer in storm water would confirm the presence of domestic wastewater, and the tracer concentration relative to "pure" sewage would allow for calculation of the relative contribution to the storm water flow.

Unfortunately, no such ideal tracer exists. Several potential tracer compounds exist, but all either have sources other than domestic wastewater, change over time, or both. The following is a listing of potential tracer compounds considered for this sampling effort:

Fluoride - Fluoride can be used as a tracer in areas where it is added to public drinking water and thus becomes a component of domestic sewage. It is a stable salt that maintains a constant concentration over time. It is not normally present in ground water or storm water. Its presence in storm water collection systems could indicate the presence of domestic, commercial, or industrial wastewater, or indicate leaks from the potable water distribution system are entering the storm water pipes. Because Puerto Rico does not fluoridate its drinking water, fluoride was not considered as a tracer for this sampling effort.

Ammonia - Ammonia is a normal constituent of domestic sewage. In fresh sewage it will have a typical concentration of 15-25 mg/l. As the sewage ages, the ammonia concentration may go up as organic nitrogen compounds in the sewage hydrolyze. Under aerobic conditions, it may also decrease as certain bacteria oxidize the ammonia to nitrate nitrogen. Ammonia is not normally present in ground water or storm water, but may be present in storm water runoff if fertilizers have been applied to surface vegetation. Ammonia was selected as an analytical parameter for the sampling effort.

Caffeine - Caffeine is a relatively stable compound present in coffee, tea, colas, other beverages, and some pharmaceuticals. It is not significantly metabolized by the human body and thus is present in domestic sewage. It is not a constituent of ground water or storm water. It is unlikely to be present in industrial wastewater, except for those that

produce or handle the products listed above. Caffeine was selected as an analytical parameter for the sampling effort.

Biochemical Oxygen Demand (BOD) - BOD is not a specific compound, but rather a measure of all biodegradable organic compounds present in a sample. Normal domestic sewage has a BOD content that ranges from 110 to 220 mg/l. BOD is either not present or present at very low levels in groundwater and storm water. However, the BOD of storm water may be increased by organic material present on streets or in storm inlets. It is difficult to predict the BOD contribution that may be present in commercial or industrial discharges. BOD was selected as an analytical parameter for the sampling effort.

Potassuim - Potassium is a normal constituent of domestic sewage. Normal domestic sewage has a potassium content of 5 to 6 mg/l. Potassium will not normally be found in rain water or urban runoff. It will not normally be present in rainfall produced ground water, however seawater may contain several hundred mg/l of potassium. Therefore potassium may not be a effective indicator of domestic sewage where there is seawater present in the ground water. Potassium was selected as an analytical parameter for the sampling effort.

Surfactants - Surfactants are a class of sulfonated organic compounds commonly referred to as detergents. They are a normal constituent of domestic sewage as a result of there use for laundry, dishwashing, and other household cleaning activities. Normal domestic sewage has a surfactant concentration of around 1 to 2 mg/l, although laundry wastewater may have concentrations of 25 mg/l or higher. Thus the concentration in domestic wastewater may be higher in the early part of the day, and lower in the night time hours. Surfactants are not found in groundwater, seawater, or storm water; however activities such as outdoor car washing may result in surfactants entering storm water inlets. Surfactants were selected as an analytical parameter for the sampling program.

Bacterial Parameters - The bacterial parameters selected for this sampling effort included Total Coliforms (TF), Fecal Coliforms (FC), and Enterococcus. These organisms do not necessarily cause disease in humans. They are good indicators of microbiological contamination and are used as a substitute by health authorities for disease causing organisms (such as hepatitis, dysentery, cholera, etc) that are likely to be present in sewage but are difficult to analyze for directly. Also, traditional culture methods used to identify harmful bacteria can present a risk to the researcher, whereas TF, FC, and Enterococcus are not likely to be hazardous in the laboratory environment. However, while these parameters can indicate qualitatively whether a sample is contaminated, they do not provide an effective quantitative measure of the degree of contamination.

Total Coliforms are a group of closely related, mostly harmless bacteria that live in soil and water as well as the gut of animals. Because of their ability to live in various environments, investigations for contamination by animal or human wastes must include other indicators in addition to Total Coliforms, such as Fecal Coliforms.

Fecal Coliforms are a sub-group of Total Coliforms, the most common member being *Escherichia coli* (*E. coli*). These organisms are associated only with the fecal material of warm-blooded animals.

Enterococcus is another type of bacteria that is present in human and animal waste. Enterococcus has been shown to have a greater correlation in marine waters with swimming-associated illnesses than other bacterial organisms.

Total Coliform concentrations in domestic sewage have been reported (*Katonak and Rose, 2003*) to range from 10^5 to 10^7 colony forming units (CFU) per 100 milliliters (ml). Fecal Coliform concentrations are reported to range from 10^4 to 10^7 CFU, and Enterococcus concentrations range from 10^3 to 10^5 CFU. However, die-off rates of the indicated bacteria vary greatly depending on specific conditions. Each of these bacterial parameters were selected as analytical parameters for the sampling program.

Temperature - Temperature is a physical parameter. Although determined for each of the samples collected, it is not useful as a tracer parameter. Storm water, ground water, and domestic sewage would all be expected to have a temperature near or below ambient temperature. Extremely high temperature values might indicate the presence of an industrial discharge. Temperature was determined for the samples collected.

pH - pH is a measure of the acid content of a sample. Storm water, ground water, and domestic sewage would all be expected to have a pH within the range of 6.0 to 8.0 pH units. Samples with a pH outside the expected range might indicate the presence of an industrial discharge. A pH determination was done for the samples collected.

Chlorine Residual - The presence of free chlorine would potentially interfere with BOD or bacterial testing since chlorine is toxic to micro-organisms. Chlorine would not be present in storm water, but could enter the storm water collection system if potable water were leaking from the drinking water supply system. Any significant concentration of organic material in the storm water system would rapidly reduce any free chlorine present. A chlorine residual field test was done for the samples collected.

4. Sampling Results

The following summarizes the sampling results obtained during the sampling program at each of the locations sampled. The results for each individual sample collected are presented in Attachments 2, 3, and 4 to this report.

Los Corozas Sewage Pump Station (Background Samples)

The Los Corozas Pump Station is a sanitary system lift station. (See Photo 1) It is located adjacent to the Baldorioty de Castro Expressway, not far from the Baldorioty de Castro Storm Water Pump Station. It was sampled to establish reference concentrations for sanitary sewage in the San Juan area. The station receives domestic sanitary wastewater, wastewater from commercial activities, and presumably some level of infiltration and inflow. Since there was no measurable rainfall during the sampling period, it is unlikely that any inflow occurred during the period when samples were collected.

Samples were collected from a channel where the flow enters the wet well passes prior passing through a bar screen. (See Photo 2) During the sampling, SAIC noted water marks on the walls in the area where the samples were collected. The water marks would indicate that the pump station has flooded on one or more occasions in the past, either due to high flows or pump station failure.

Table 1. Summary of Los Corozas Sampling Results
Samples Collected August 22, 23, and 24, 2006

Parameter	Average	Range
BOD (mg/l)	96	41[1] - 148
Ammonia (mg/l)	26	18.0 - 38.0
Surfactants (mg/l)	3.9	3.5 - 4.3
Potassium (mg/l)	22	22 - 22
Caffeine (ug/l)	23.6	21.8 - 26.7
Total Coliform (cfu/100 ml) Daily Geometric Mean	23,996,000	11,145,000 - 33,928,000
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	10,360,000	5,305,000 - 14,737,000
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	1,306,000	1,001,000 - 1,738,000

[1] The composite BOD value for 8/23 was 41 mg/l. This would be an unusually low value for domestic sewage and may be an anomaly.

Baldorioty de Castro Storm Water Pump Station

The Baldorioty de Castro Storm Water Pump Station is located adjacent to the Baldorioty de Castro Expressway in Santurce. (See Photo 3) Storm water enters the open wet well of the pump station through two pipes. The first brings flow under the Expressway from the residential area to the north. The second serves the neighborhood to the west of the pump station. (See Photo 4) The station utilizes one 50,000 gallon per minute (gpm) pump, and three 100,000 gpm pumps. Automatic controls for the pumps are not used. Operators turn pumps on and off manually based on the level in the wet well. The run time for each pump is recorded by the operators. The discharge is to an open channel that flows to the Las Corozas Lagoon (Laguna Los Corozas).

There is daily flow discharged from the pump station. This is likely due to groundwater infiltration into the system, and may also include illicit sanitary sewage connections to the storm water pipes. Flow from the station was 7,950,000 gallons on August 22nd, 5,300,000 gallons on August 23rd, and 4,400,000 gallons on August 24th. These flow estimates are based on pump run times and nominal pump capacity. No measurable rainfall occurred on these days.

The operators at the station stated that at times during wet weather operation they see evidence of sanitary sewage, such as paper and plastic debris, entering the wet well. When this happens, the call the operator at the Los Corozas pump station.

The SAIC sampling team noted the body of an animal (probably a dog) floating in the wet well during all three days of the sampling. (See Photo 5) When the SAIC team arrived at the station the morning of August 23rd, there was a strong smell of petroleum in the area around the wet well. A floating layer of petroleum was visible on the surface of the wet well. Both the odor and petroleum sheen were present in the wet well through the end of the following day. The operators at the station believed the material was gasoline, and that it had originated from one of two Gulf stations located to the west of the pump station. One of the Gulf stations is located on the south side or the Expressway, and the other on the north side. No attempt was made by the operators to remove either the animal carcass or the hydrocarbon material from the wet well during the time the station was sampled.

Samples were collected directly from the wet well. Sampling was done at the south end of the wet well where it was judged that the flows from the two incoming pipes had been mixed.

Table 2. Summary of Baldorioty de Castro Storm Water PS Sampling Results
Samples Collected August 22, 23, and 24, 2006

Parameter	Average	Range
BOD (mg/l)	29	20 - 34
Ammonia (mg/l)	5.1	4.6 - 5.9
Surfactants (mg/l)	1.9	1.7 - 2.3
Potassium (mg/l)	33	30 - 35
Caffeine (ug/l)	9.16	5.67 - 12.8
Total Coliform (cfu/100 ml) Daily Geometric Mean	4,965,000	3,577,000 - 7,452,000
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	1,433,000	877,000 - 2,417,000
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	123,000	68,000 - 202,000

The values for potassium were higher for all samples than those measured at the baseline (Los Corozas) station. Because seawater contains high concentrations of potassium, it is likely that seawater infiltration is a contributing source of potassium in the samples from this location.

A procedure was developed to estimate the quantity of sewage present in the storm water. The average concentrations of the baseline samples (Los Carozas) for each parameter. The percentage (of the average baseline concentration) for the highest and lowest concentration for each parameter was calculated to estimate the highest and lowest percentage of sewage likely to be present in the storm water. The median value of the highest and lowest percentage concentration for all of the parameters was then determined to estimate the percentage of sewage present in the storm water. Bacterial parameters were not used to determine the sewage present because of the rapid die-off rate for bacteria. For the Baldorioty de Castro pump station, potassium was not included in the calculation since it is believed that seawater infiltration contributed to the concentrations measured. The results of the estimating approach for the Baldorioty de Castro Storm Water Pump Station are shown in Table 3.

Table 3. Calculations to Estimate the Quantity of Sewage Present in the Baldorioty de Castro Storm Water Pump Station Samples

Parameter	Average Baseline Conc.	Average SW Sample Conc.	Average Percentage of Sewage	Minimum Percentage of Sewage	Maximum Percentage of Sewage
BOD (mg/l)	96	29	30	21	35
Ammonia (mg/l)	26	5.1	20	18	23
Surfactants (mg/l)	3.9	1.9	49	44	59
Caffeine (ug/l)	23.6	9.16	39	24	54
Median Average, Minimum, and Maximum Percentage of Sewage Present			34	22	44

Based on the analytical results exclusive of potassium, SAIC would estimate the volume of domestic sewage entering the storm water system to be 22 to 44 percent of the total flow. This is based on the concentrations of the various chemical parameters when compared to the concentrations of the same parameters in the influent to the baseline pump station as shown above. While an exact portion of sewage is difficult to estimate based on the results, it is clear that a significant flow of domestic sewage enters this station and is discharged without treatment.

De Diego Storm Water Pump Station

The De Diego Storm Water Pump Station is located on De Diego Avenue, just north of the Baldorioty de Castro Expressway in Santurce. The surrounding neighborhood is residential and light commercial. The station utilizes two 39,000 gallon per minute (gpm) pumps, and one 15,000 gpm pump. Automatic controls for the pumps are not used. Operators turn pumps on and off manually based on the level in the wet well. The run time for each pump is recorded by the operators. The discharge is piped underground to the Atlantic Ocean.

There is daily flow discharged from the pump station. This is likely due to groundwater infiltration into the system, and may also include illicit domestic sewage connections to the storm water pipes. Flow from the station was 630,000 gallons on August 22nd, 450,000 gallons on August 23rd, and 405,000 gallons on August 24th. These flow estimates are based on pump run times and nominal pump capacity. No measurable rainfall occurred on these days.

The SAIC sampling team noted that on August 22, and the morning of August 23rd, the samples collected contained a significant quantity of suspended material that appeared to be brown and fibrous. When the team arrived at the station at 2:26 PM on August 23rd, the flow was clear for the first time. The flow remained clear on the following day. The source of the material is not

known, nor is it known if the cessation of the discharge was related to the discharge source becoming aware of the sampling program. In comparing the sampling results from the 22nd and 24th, it does not appear the material contributed significant amounts of the parameters sampled. A possible exception was surfactants, which were highest in the August 22nd sample, and decreased on subsequent days.

Samples were collected from a channel that conveys the incoming flow to the wet well. (See Photo 6) The flow rate appeared to be relatively constant during the sampling effort.

Table 4. Summary of De Diego Storm Water PS Sampling Results
Samples Collected August 22, 23, and 24, 2006

Parameter	Average	Range
BOD (mg/l)	20	19 - 21
Ammonia (mg/l)	2.2	<1 - 2.5
Surfactants (mg/l)	0.43	0.24 - 0.69
Potassium (mg/l)	5.0	4.6 - 5.2
Caffeine (ug/l)	4.86	3.55 - 5.88
Total Coliform (cfu/100 ml) Daily Geometric Mean	1,588,000	467,000 - 2,275,000
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	487,000	341,000 - 670,000
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	19,000	8,400 - 26,300

The quantity of sewage entering the De Diego Storm Water Pump Station was estimated using the same procedure described for the Baldorioty de Castro Pump Station. The results of the estimating approach are shown in Table 5.

Table 5. Calculations to Estimate the Quantity of Sewage Present in the De Diego Storm Water Pump Station Samples

Parameter	Baseline Conc.	Average SW Sample Conc.	Average Percentage of Sewage	Average Percentage of Sewage	Maximum Percentage of Sewage
BOD (mg/l)	96	20	21	20	22
Ammonia (mg/l)	26	2.2	8	<4	10
Surfactants (mg/l)	3.9	0.43	11	62	18
Potassium (mg/l)	22	5.0	23	21	24
Caffeine (ug/l)	23.6	4.86	21	15	25
Median Average, Minimum, and Maximum Percentage of Sewage Present			21	20	22

Based on the analytical results SAIC would estimate the volume of domestic sewage entering the storm water system to be 20 to 22 percent of the total flow. While an exact portion of sewage is difficult to estimate based on the results, it is clear that at least some domestic sewage enters this station and is discharged without treatment.

La Malaria Pump Station (Catano)

The La Malaria Pump Station is located in a residential neighborhood of Catano on Bay View Road just east of the Baccardi Rum Visitors Center. The station pumps drainage from a marshy area to the south of the road to the Atlantic Ocean. (See Photo 7) Information provided by the Department of Natural Resources indicates the station is equipped with three 50,000 gpm pumps. There is generally a single operator present at the station. Because of mechanical problems at the station, flow records were not being kept at the time of the sampling. Reportedly, the station discharges an average of about 7.2 million gallons per day.

Samples were collected at the intake screens prior to the pumps. Water at this point was generally quiescent with some greenish turbidity probably due to the presence of algae. (See Photo 8)

Table 6. Summary of La Malarina (Catano) PS Sampling Results
Samples Collected August 22, 23, and 24, 2006

Parameter	Average	Range
BOD (mg/l)	31	14 - 47
Ammonia (mg/l)	<1	<1 - <1
Surfactants (mg/l)	1.23	0.22 - 2.9
Potassium (mg/l)	3.9	3.7 - 4.2
Caffeine (ug/l)	0.14	0.098 - 0.193
Total Coliform (cfu/100 ml) Daily Geometric Mean	42,700	21,100 - 59,300
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	8,200	2,000 - 18,700
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	2,300	671 - 5,144

A portion of the BOD present in the water may have been due to the vegetation in the area. The absence of ammonia may have been the result of algae or fixed plant uptake. The presence of surfactants may be an indicator of domestic sewage contamination, however the concentration measured varied significantly during the three days of sampling. Potassium was relatively high when compared with the baseline sewage concentration, but may have been due to seawater infiltration. Measured results for caffeine were relatively low.

The quantity of sewage entering the La Malarina (Catano) Storm Water Pump Station was estimated using the same procedure described for the Baldorioty de Castro Pump Station. The results of the estimating approach are shown in Table 7.

Table 7. Calculations to Estimate the Quantity of Sewage Present in the La Malarina Storm Water Pump Station Samples

Parameter	Baseline Conc.	Average SW Sample Conc.	Average Percentage of Sewage	Minimum Percentage of Sewage	Maximum Percentage of Sewage
BOD (mg/l)	96	31	32	15	49
Ammonia (mg/l)	26	<1	<4	<4	<4
Surfactants (mg/l)	3.9	1.23	31	6	74
Potassium (mg/l)	22	3.9	18	17	19
Caffeine (ug/l)	23.6	0.14	<1	0	1
Median Average, Minimum, and Maximum Percentage of Sewage Present			18	10	34

Sampling results were somewhat ambiguous with regard to the presence of sewage at this location. The analysis for BOD and surfactants would suggest the possibility that as much as 30 percent of the flow could be of domestic sewage origin. However, concentrations of ammonia and caffeine would suggest less than 1 percent domestic sewage, if any. Potassium results may be influenced by seawater infiltration due to the close proximity to the ocean. Low bacterial levels may indicate low levels of contamination, but could also be indicative of sunlight disinfection in the shallow slow moving water. The calculations above not-with-standing, SAIC cannot conclude with any certainty that there is significant domestic sewage contamination of the storm water at this location.

Stop 18 Pump Station (Parada 18)

The Stop 18 storm water pump station is located on Villamil Street in Santurce. Information provided by the Department of Natural Resources indicates the station is equipped with two 75,000 gpm pumps, and one 50,000 gpm pump. The information appears to indicate that only the 50,000 gpm pump is operational. The station discharges to the Martin Pena Canal. Flow from the station was 5,800,000 gallons on August 22nd, 5,350,000 gallons on August 23rd, and 6,800,000 gallons on August 24th. These flow estimates are based on pump run times and nominal pump capacity. No measurable rainfall occurred on these days.

Sampling was done at the point where the incoming flow enters the wet well of the station.

Table 8. Summary of Stop 18 (Parada 18) PS Sampling Results
Samples Collected August 21, and 23, 2006[1]

Parameter	Average	Range
BOD (mg/l)	67	NA
Ammonia (mg/l)	20.0	NA
Surfactants (mg/l)	5.0	NA
Potassium (mg/l)	9.3	NA
Caffeine (ug/l)	21.3	NA
Total Coliform (cfu/100 ml) Daily Geometric Mean	18,700,000	8,166,000 - 29,212,000
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	5,986,000	3,314,000 - 8,659,000
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	5,762,000	1,140,000 - 10,383,000

[1] Chemical samples were only collected on August 21, 2006. Bacterial samples were collected on August 21 and 23, 2006.

The quantity of sewage entering the Stop 18 (Parada 18) Storm Water Pump Station was estimated using the same procedure described for the Baldorioty de Castro Pump Station. The results of the estimating approach are shown in Table 9.

Table 9. Calculations to Estimate the Quantity of Sewage Present
in the Stop 18 (Parada 18) Storm Water Pump Station Samples

Parameter	Baseline Conc.	SW Sample Conc.	Percentage of Sewage
BOD (mg/l)	96	67	70
Ammonia (mg/l)	26	20	77
Surfactants (mg/l)	3.9	5.0	128
Potassium (mg/l)	22	9.3	42
Caffeine (ug/l)	23.6	21.3	90
Median Percentage of Sewage Present			77

In reviewing the analytical data SAIC would note that both surfactants and Enterococcus levels were higher than those detected at the baseline location. Based on the estimating approach used, SAIC estimates the volume of domestic sewage entering the storm water system to be about 77 percent. The analysis is hampered by the fact that only one set of chemical samples was collected. While an exact portion of sewage is difficult to estimate based on the results, it is clear that a significant flow of domestic sewage enters this station and is discharged without treatment.

Miramar Discharge Pipe

The Miramar sampling location was a manhole on a pipe leading to San Juan Bay. The manhole was identified for sampling by Mr. Carlos Villafane of the USEPA Carribean Field Office. According to Mr. Villafane, the pipe that was sampled is a bypass pipe from a 42" interceptor pipe. Mr. Villafane stated that the 42" pipe goes to a treatment plant, but because of severe infiltration and inflow problems the 42" pipe was intentionally plugged to prevent high hydraulic loads to the plant. This results in all flow in the pipe being diverted to San Juan Bay without treatment.

Table 10. Summary of Miramar Pipe Sampling Results
Samples Collected August 21, and 23, 2006[1]

Parameter	Average	Range
BOD (mg/l)	59	NA
Ammonia (mg/l)	9.1	NA
Surfactants (mg/l)	7.2	NA
Potassium (mg/l)	7.7	NA
Caffeine (ug/l)	18.9	NA
Total Coliform (cfu/100 ml) Daily Geometric Mean	18,700,000	8,166,000 - 29,212,000
Fecal Coliform (cfu/100 ml) Daily Geometric Mean	5,986,000	3,314,000 - 8,659,000
Fecal Enterococcus (cfu/100 ml) Daily Geometric Mean	5,762,000	1,140,000 - 10,383,000

[1] Chemical samples were only collected on August 21, 2006. Bacterial samples were collected on August 21 and 23, 2006.

The quantity of sewage entering the Miramar Sewer Pipe was estimated using the same procedure described for the Baldorioty de Castro Pump Station. The results of the estimating approach are shown in Table 11.

Table 11. Calculations to Estimate the Quantity of Sewage Present in the Miramar Sewer Pipe Samples

Parameter	Baseline Conc.	SW Sample Conc.	Percentage of Sewage
BOD (mg/l)	96	59	61
Ammonia (mg/l)	26	9.1	35
Surfactants (mg/l)	3.9	7.2	185
Potassium (mg/l)	22	7.7	35
Caffeine (ug/l)	23.6	18.9	80
Median Percentage of Sewage Present			61

In reviewing the analytical data SAIC would note that both surfactants and Enterococcus levels were higher than those detected at the baseline location. Based on the estimating procedure used, SAIC estimates the volume of domestic sewage entering the storm water system to be 61 percent of the total flow. The analysis is hampered by the fact that only one set of chemical samples was collected. While an exact portion of sewage is difficult to estimate based on the results, it is clear that a significant flow of domestic sewage enters this pipe and is discharged without treatment.

ATTACHMENT 1
PHOTO LOG

Photo 1 - Exterior of the Las Corozas Sanitary Pump Station

Photo 2 - Sampling point at the entrance to the Las Corozas wet well.

Photo 3 - Baldorioty de Castro Storm Water PS

Photo 4 - Sampling point at Baldorioty de Casto SWPS. Note pipes entering at far end and left.

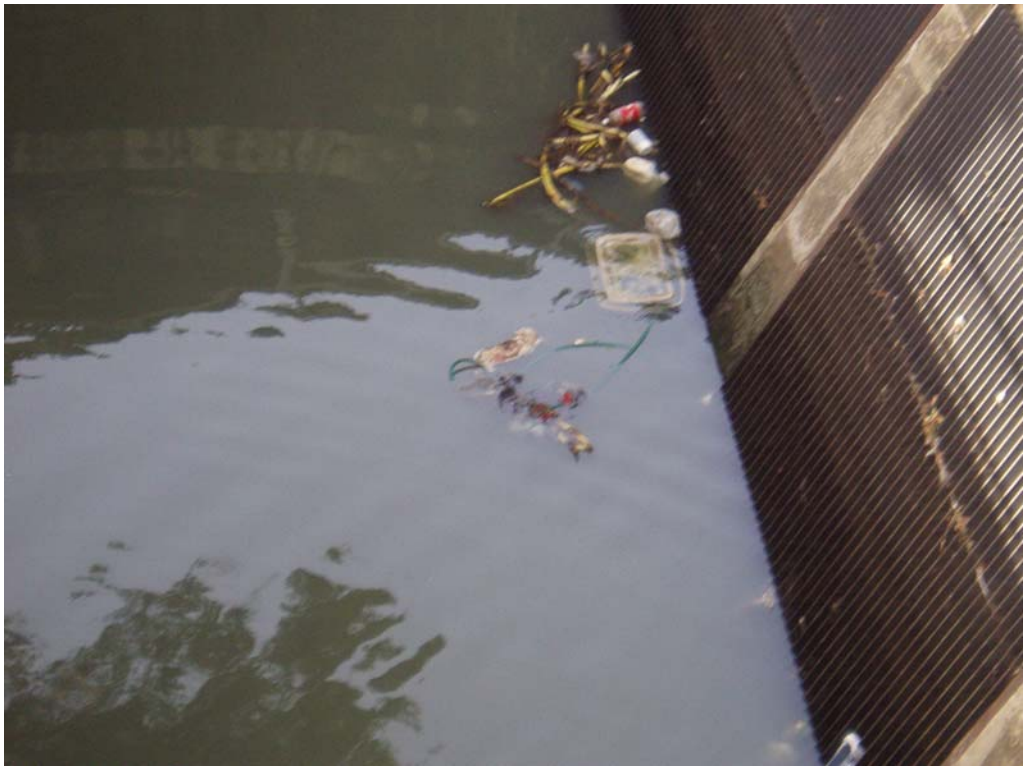

Photo 5 - Close up of debris in Baldorioty de Castro wet well. Debris at photo center includes animal carcass.

Photo 6 - Sampling point at De Deigo Storm Water PS. Location is at entrance to the wet well.

Photo 7 - Vegetated area that drains to the La Malaria Storm Water PS.

Photo 8 - Sampling point for La Malaria SW PS.

ATTACHMENT 2
FIELD DATA

Location	Date	Time	pH	Temperature (centigrade)	Chlorine Residual
Baldoriorty de Castro SW PS	8/22/06	8:14 AM	7.4	29.4	0.0
Baldoriorty de Castro SW PS	8/22/06	10:43 AM	7.4	32.0	0.0
Baldoriorty de Castro SW PS	8/22/06	3:42 PM	7.5	30.5	0.0
Baldoriorty de Castro SW PS	8/23/06	7:50 AM	7.4	29.6	0.0
Baldoriorty de Castro SW PS	8/23/06	11:03 AM	7.4	30.5	0.0
Baldoriorty de Castro SW PS	8/23/06	2:05 PM	7.4	30.2	0.0
Baldoriorty de Castro SW PS	8/24/06	7:57 AM	7.4	29.3	0.0
Baldoriorty de Castro SW PS	8/24/06	10:03 AM	7.8	30.0	0.0
De Diego SW PS	8/22/06	9:02 AM	7.7	28.90	0.0
De Diego SW PS	8/22/06	11:25 AM	7.8	29.8	0.0
De Diego SW PS	8/22/06	3:19 PM	7.6	30.00	0.0
De Diego SW PS	8/23/06	8:20 AM	7.8	29.50	0.0
De Diego SW PS	8/23/06	11:25 AM	7.8	29.50	0.0
De Diego SW PS	8/23/06	2:26 PM	7.7	30.00	0.0
De Diego SW PS	8/24/06	8:35 AM	7.8	29.00	0.0
De Diego SW PS	8/24/06	11:00 AM	7.7	29.80	0.0
Catano SW PS	8/22/06	9:49 AM	7.7	28.5	0.0
Catano SW PS	8/22/06	12:05 PM	7.0	29.10	0.0
Catano SW PS	8/22/06	2:45 PM	7.0	31.70	0.0
Catano SW PS	8/23/06	8:55 AM	7.3	28.20	0.0
Catano SW PS	8/23/06	11:51 AM	7.0	29.80	0.0
Catano SW PS	8/24/06	9:04 AM	7.1	28.40	0.0
Catano SW PS	8/24/06	11:25 AM	7.0	30.00	0.0
Corozas Sewage Pump Station	8/22/06	7:45 AM	7.2	29.4	0.0
Corozas Sewage Pump Station	8/22/06	10:26 AM	7.1	28.9	0.0
Corozas Sewage Pump Station	8/23/06	10:50 AM	7.1	28.9	0.0
Corozas Sewage Pump Station	8/23/06	1:54 PM	7.1	30.7	0.0
Corozas Sewage Pump Station	8/24/06	7:35 AM	7.3	30.2	0.0
Corozas Sewage Pump Station	8/24/06	9:51 AM	7.3	30.1	0.0
Miramar Discharge Pipe	8/21/06	1:50 PM	7.1	31.4	0.0
Miramar Discharge Pipe	8/23/06	10:08 AM	7.1	30.1	0.0
Parada 18 SW PS	8/21/06	2:55 PM	7.2	30.6	0.0
Parada 18 SW PS	8/23/06	9:30 AM	7.9	31.5	0.0

ATTACHMENT 3
COMPOSITE DATA

Location	Date	BOD (mg/l)	Ammonia (mg/l)	Surfactants (mg/l)	Potassium (mg/l)	Caffeine (ug/l)
Baldoriorty de Castro SW PS	8/22/06	23	4.9	2.3	35	12.8
Baldoriorty de Castro SW PS (1)	8/22/06	17	4.9	1.9	35	11.7
Baldoriorty de Castro SW PS	8/23/06	33	4.6	1.7	34	5.67
Baldoriorty de Castro SW PS	8/24/06	34	5.9	1.8	30	9.56
De Diego SW PS	8/22/06	21	<1	0.69	5.1	3.55
De Diego SW PS (2)	8/23/06	31	N/A	N/A	N/A	N/A
De Diego SW PS	8/23/06	21	2.2	0.36	5.2	5.16
De Diego SW PS	8/24/06	19	2.5	0.24	4.6	5.88
Catano SW PS	8/22/06	47	<1	2.9	3.7	0.193
Catano SW PS	8/23/06	14	<1	0.57	4.2	0.13
Catano SW PS	8/24/06	32	<1	0.22	3.9	0.105
Catano SW PS (1)	8/24/06	30	<1	0.22	3.9	0.091
Corozas Sewage Pump Station	8/22/06	148	29.0	3.5	22	21.8
Corozas Sewage Pump Station	8/23/06	41	18.0	3.9	22	26.7
Corozas Sewage Pump Station	8/24/06	115	38.0	4.3	22	22.4
Miramar Discharge Pipe	8/21/06	59	9.1	7.2	7.7	18.9
Parada 18 SW PS	8/21/06	67	20.0	5.0	9.3	21.3

Notes:

(1) Duplicate Sample

(2) Grab Sample (See text)

ATTACHMENT 4
BACTERIAL DATA

Location	Date	Time	Total Coliform	Fecal Coliform	Fecal Entrococcus
Baldoriorty de Castro SW PS	8/22/06	8:22	4,100,000	860,000	79,000
Baldoriorty de Castro SW PS	8/22/06	8:24	3,700,000	940,000	57,000
Baldoriorty de Castro SW PS	8/22/06	8:26	2,800,000	1,100,000	84,000
Baldoriorty de Castro SW PS	8/22/06	10:50	3,900,000	1,200,000	77,000
Baldoriorty de Castro SW PS	8/22/06	10:50	5,200,000	960,000	51,000
Geometric Mean			3,864,046	1,004,834	68,292
Baldoriorty de Castro SW PS	8/23/06	7:55	4,200,000	580,000	70,000
Baldoriorty de Castro SW PS	8/23/06	7:57	2,100,000	880,000	83,000
Baldoriorty de Castro SW PS	8/23/06	7:59	3,800,000	890,000	96,000
Baldoriorty de Castro SW PS	8/23/06	11:05	4,600,000	1,300,000	130,000
Baldoriorty de Castro SW PS	8/23/06	11:08	3,800,000	880,000	140,000
Geometric Mean			3,577,328	877,294	100,301
Baldoriorty de Castro SW PS	8/24/06	8:05	7,800,000	6,900,000	63,333
Baldoriorty de Castro SW PS	8/24/06	8:06	4,100,000	720,000	72,500
Baldoriorty de Castro SW PS	8/24/06	8:08	6,600,000	1,165,000	54,000
Baldoriorty de Castro SW PS	8/24/06	10:05	11,000,000	4,430,000	1,125,000
Baldoriorty de Castro SW PS	8/24/06	10:12	9,900,000	3,220,000	1,200,000
Geometric Mean			7,452,295	2,417,427	201,808
De Diego SW PS	8/22/06	9:08	2,800,000	480,000	8,100
De Diego SW PS	8/22/06	9:10	3,500,000	570,000	9,600
De Diego SW PS	8/22/06	9:12	1,900,000	500,000	11,000
De Diego SW PS	8/22/06	11:27	1,400,000	370,000	7,600
De Diego SW PS	8/22/06	11:29	1,300,000	360,000	6,300
Geometric Mean			2,023,067	448,867	8,365
De Diego SW PS	8/23/06	8:30	2,200,000	990,000	13,000
De Diego SW PS	8/23/06	8:32	3,400,000	970,000	38,000
De Diego SW PS	8/23/06	8:33	3,300,000	860,000	25,000
De Diego SW PS	8/23/06	11:26	1,300,000	340,000	21,000
De Diego SW PS	8/23/06	11:30	1,900,000	480,000	22,000
Geometric Mean			2,275,215	669,769	22,452
De Diego SW PS	8/24/06	8:38	486,000	369,000	36,000
De Diego SW PS	8/24/06	8:40	480,000	327,000	18,000
De Diego SW PS	8/24/06	8:42	436,000	331,000	28,000
De Diego SW PS	8/24/06	Sample Lost			
De Diego SW PS	8/24/06	Sample Lost			
Geometric Mean			466,790	341,823	26,277
Catano SW PS	8/22/06	9:49	31,000	8,000	2,100
Catano SW PS	8/22/06	9:51	34,000	6,300	1,100
Catano SW PS	8/22/06	9:55	80,000	5,300	1,200
Catano SW PS	8/22/06	12:10	61,000	2,000	630
Catano SW PS	8/22/06	12:15	48,000	2,000	1,500
Geometric Mean			47,698	4,034	1,212

Catano SW PS	8/23/06	9:07	21,000	2,000	900
Catano SW PS	8/23/06	9:02	20,000	2,500	990
Catano SW PS	8/23/06	9:05	22,000	1,800	900
Catano SW PS	8/23/06	11:55	18,000	2,100	270
Catano SW PS	8/23/06	11:58	25,000	1,800	630
Geometric Mean			21,075	2,025	671
Catano SW PS	8/24/06	9:08	41,333	37,000	6,000
Catano SW PS	8/24/06	9:10	400,000	300,000	100,000
Catano SW PS	8/24/06	9:12	56,500	51,000	1,000
Catano SW PS	8/24/06	11:30	19,500	2,000	3,000
Catano SW PS	8/24/06	11:32	40,333	2,000	2,000
Geometric Mean			59,323	18,663	5,144
Corozas Sewage Pump Station	8/22/06	7:50	21,000,000	8,600,000	880,000
Corozas Sewage Pump Station	8/22/06	7:52	25,000,000	9,400,000	1,200,000
Corozas Sewage Pump Station	8/22/06	7:56	31,000,000	13,000,000	1,400,000
Corozas Sewage Pump Station	8/22/06	10:29	28,000,000	12,000,000	1,400,000
Corozas Sewage Pump Station	8/22/06	10:33	31,000,000	13,000,000	1,100,000
Geometric Mean			26,915,853	11,039,232	1,178,861
Corozas Sewage Pump Station	8/23/06	7:32	32,000,000	15,000,000	980,000
Corozas Sewage Pump Station	8/23/06	7:34	31,000,000	13,000,000	1,000,000
Corozas Sewage Pump Station	8/23/06	7:36	37,000,000	18,000,000	1,100,000
Corozas Sewage Pump Station	8/23/06	10:52	35,000,000	18,000,000	980,000
Corozas Sewage Pump Station	8/23/06	10:55	35,000,000	11,000,000	950,000
Geometric Mean			33,928,909	14,736,504	1,000,723
Corozas Sewage Pump Station	8/24/06	7:40	8,300,000	5,805,000	1,685,000
Corozas Sewage Pump Station	8/24/06	7:42	9,500,000	3,645,000	1,565,000
Corozas Sewage Pump Station	8/24/06	7:44	14,300,000	6,305,000	1,875,000
Corozas Sewage Pump Station	8/24/06	7:46	12,300,000	6,700,000	1,930,000
Corozas Sewage Pump Station	8/24/06	7:48	12,400,000	4,700,000	1,660,000
Geometric Mean			11,145,329	5,304,830	1,737,626
Miramar Discharge Pipe	8/21/06	14:00	5,200,000	3,400,000	5,400,000
Miramar Discharge Pipe	8/21/06	14:00	4,600,000	2,600,000	8,500,000
Miramar Discharge Pipe	8/21/06	14:05	5,900,000	3,400,000	7,400,000
Miramar Discharge Pipe	8/21/06	14:07	5,800,000	3,000,000	6,800,000
Miramar Discharge Pipe	8/21/06	14:10	6,200,000	3,100,000	14,400,000
Geometric Mean			5,509,175	3,085,196	8,023,857
Miramar Discharge Pipe	8/23/06	10:11	27,000,000	12,000,000	980,000
Miramar Discharge Pipe	8/23/06	10:13	27,000,000	10,000,000	1,100,000
Miramar Discharge Pipe	8/23/06	10:15	29,000,000	10,000,000	1,000,000
Miramar Discharge Pipe	8/23/06	10:16	30,000,000	10,000,000	1,300,000
Miramar Discharge Pipe	8/23/06	10:17	30,000,000	10,000,000	930,000
Geometric Mean			28,567,590	10,371,373	1,054,409
Parada 18 SW PS	8/21/06	15:09	8,400,000	4,000,000	8,800,000
Parada 18 SW PS	8/21/06	15:10	7,700,000	2,500,000	15,000,000
Parada 18 SW PS	8/21/06	15:10	7,700,000	4,100,000	9,500,000

Parada 18 SW PS	8/21/06	15:12	8,100,000	2,500,000	12,500,000
Parada 18 SW PS	8/21/06	15:16	9,000,000	3,900,000	7,700,000
Geometric Mean			8,165,780	3,314,040	10,383,402
Parada 18 SW PS	8/23/06	9:41	63,000,000	7,200,000	950,000
Parada 18 SW PS	8/23/06	9:36	13,000,000	8,700,000	930,000
Parada 18 SW PS	8/23/06	9:38	37,000,000	14,000,000	1,200,000
Parada 18 SW PS	8/23/06	9:50	27,000,000	7,400,000	1,300,000
Parada 18 SW PS	8/23/06	9:54	26,000,000	7,500,000	1,400,000
Geometric Mean			29,212,219	8,658,737	1,140,491